

# UNIVERSITY OF CALIFORNIA.

## AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 53.

### Irrigation, Drainage and Alkali.

About two years ago, California was visited by Mr. W. J. Wilson, an English engineer connected with the Government of "The Northwest Provinces and Oudh," India, with a view to studying the subjects indicated in the above heading in their connection with California practice. He was given such information and assistance toward the accomplishment of his object as could be afforded by the agricultural department of the University and the State Engineer's office at Sacramento; and he visited personally several prominent alkali districts in the State. In letters subsequently received from him, he dwelt strongly upon the exact analogy of the phenomena of "alkali" as appearing in the two countries, and expressed the hope that California would profit in time by the bitter experience of "the oldest country in the world." What this experience has been, is pregnant set forth in a series of reports received here, not long ago, from the Director of Agriculture at the agricultural station of Cawnpore, Oudh; and the burden of their tale is so instructive, and as far as comparable so nearly akin to what exists, or has already occurred in California, that lengthy extracts from the same will be given in the report of the Agricultural College for 1886. For the present, it becomes of interest to state some of the main points, in view of the fact that in some of our irrigation districts, measures looking to the relief from the already growing evils are now under discussion.

The document in hand is entitled "*Report of the Committee for Investigating Into the Causes of the Deterioration of Land by Reh in the Aligarh District.*" This district lies southeast of the city of Delhi, between the Ganges and Jumna rivers, and is traversed by the canal system diverging from these rivers. The report refers, however, to numerous other regions, notably in the Punjab, where precisely similar conditions have been brought about as regards the scourge of "*reh*," the latter being the Hindoostanee equivalent for "alkali."

The broad facts set forth are these: Prior to the establishment of the great irrigation canals by the English Government, regular cultivation in those countries was practically restricted to the moist lands immediately along the water courses, and to such as could be laboriously irrigated from wells, the latter being very numerous. Occasionally rainy seasons would there, as in southern California, bring good harvests on unirrigated lands; but a failure of the rains

brought a famine. Tracts rendered uncultivable by excess of alkali exist more or less throughout the Northwest provinces, but under the old system of cultivation, there was no appreciable increase of the area of these *reh* lands.

The canals were built for the purpose of affording abundance of irrigation water; and in order that they might be easily available, they were laid high, so as to allow their water when used to flow naturally over or through the agricultural lands. No provision for drainage was made.

For a few years only benefits were experienced from the irrigation canals, and large plantation enterprises were set on foot where previously only scanty pasture formed the product of the land. Gradually, however, it was noted that crops began to languish in the lower ground; and soon it became apparent that the latter was being converted into rapidly enlarging swamps. More than this, it was observed that on the higher ground the *reh* spots previously existing were rapidly enlarging, and that new ones were being formed where before none had existed within the memory of man. This was, however, simply a repetition of a previous experience, thus referred to by one of the members of the committee: "When under the Moghal dynasty the Western Jumna canal was open, *reh* was (so say the people) common throughout the tract, though not so highly developed as now. During the century of Maharratta misrule the canal was closed and *reh* disappeared. The canal was re opened in 1820; and irrigation far more extensive than before was established in 1838, and swamps and *reh* were the immediate result."

So great and extended is the injury thus inflicted, that while some members of the committee discuss the possible remedies of deepening the canals, establishing deep drainage etc., one at least goes so far as to say that rather than that this state of things should be allowed to continue and increase, it were better that the canals should be closed and the old system of well irrigation restored.

There is little difference of opinion as to the cause of the evil and the source of the alkali. It is shown that not only near, but within even considerable distances from the canals, the water table or subsoil water level has been raised from a distance of 20 to 50 feet, to within a few feet of, or actually to the surface. It has brought up with it, by an easily intelligible process of upward leaching, all the alkali salts existing within the substrata thus traversed; and then by evaporation, these salts, before diffused throughout many feet of substrata, accu-



mulate at the surface to such an extent, as to render profitable cultivation impossible, if even they do not make the soil absolutely barren, by covering it with a white crust of salts. While the committee agree that the largest proportion of the damage has been brought about by the rise of the water table by sidewise soakage from the high-lying canals, yet they state that the trouble has been greatly aggravated and expanded by the extravagant use of water by the peasants, who, relieved from the laborious processes of well-irrigation, took great satisfaction in giving the land and crops a plenty, now that they had the water free of cost. It is estimated the water used often approaches 60 inches rainfall, and is equivalent to 27 inches, at least over the whole of the irrigated region.

The remedies suggested by the committee, and in part carried into practice within the last five years, are the following: First, a deepening of the canals, so as to lower their water level, and hence that of the soakage water table, several feet at least below that of the lands to be irrigated. This measure carries with it the restriction of the over-irrigation heretofore practiced, by compelling the ryots to raise the water by means of wheels or pumps, which is the second point insisted on. Third, they recommend the establishment of a system of drainage, by which the surplus subsoil water shall drain into the rivers, carrying with it also the *reh* salts, and thus relieving the land more or less permanently of that scourge.

It unfortunately happens that the first of these measures offers in many cases insuperable engineering difficulties, from the fact that the entire canal construction was calculated for high levels; so that deepening would often be equivalent to almost entire reconstruction. The establishment of drainage systems, also, offers great difficulties in a region where, from the scantiness of the rainfall, the surface conformation of the country is not favorably sculptured. The enormous cost now to be incurred in applying thoroughly either or both of these remedies, of course stands seriously in the way of their application. Had the effects of the high-laid canals and defective drainage been foreseen, a different system could have been constructed with the same, or slightly greater cost.

It is hardly necessary to go farther into the details of these interesting reports to enforce

the lesson and warning they convey to our irrigating communities. In some of the latter, the evils now besetting the irrigation districts of northwest India are already becoming painfully apparent; and to expect them not to increase unless the proper remedies are applied, is to hope that natural laws will be waived in favor of California. Some early enthusiasts have practically gone as far as this, but the sober business sense of the community has by this time come to a different conclusion. The natural conditions under which the irrigation canals of India have brought about the *reh* scourge are exactly reproduced in the great valley of California; and what has happened in India will assuredly happen there also, unless timely precautions are taken.

In several reports heretofore published (more especially in that for 1880) I have urged the necessity of drainage correlative with irrigation, in order to avoid the conversion of some of the finest agricultural lands of the San Joaquin valley into swampy alkali flats. I have urged the more sparing use of water, in order to restrict as much as possible the 'rise of the alkali' from unnecessary evaporation; and have suggested both means for preventing its accumulation near the surface, and for mitigating its corrosive qualities. Analyses of the waters of the several rivers flowing from the Sierra, as well as of those of artesian wells, have been made to show how far such waters might contribute to the increase of the alkali unless simultaneous drainage were enabled to remove the accumulation. The waters of Tulare and the other lakes of the valley, similarly tested, have been found to be unfit for irrigation, unless under exceptional conditions or precautions. Thus, with the practical experience already had, all the data for intelligent action in the premises are at hand; and according to a number of recent reports and observations, such action is in some localities becoming the question of first importance to those who would prevent their orchards and vineyards from being drowned out by water-logging, or their wheat fields from becoming one vast alkali plain. Single individuals, however, can do but little in the matter; the action to be taken must, of necessity, be that of whole communities.

E. W. HILGARD,

Berkeley, Feb. 25, 1886.